

"AN INJECTION MOULDING SYSTEM FOR A MATERIAL VULCANIZABLE  
BY HEAT"

BACKGROUND OF THE INVENTION

5

Field of the Invention

The present invention relates to an injection molding system for a material vulcanizable by heat, such as rubber, elastomers or the like.

10 State of the Prior Art

In injection molding, of the type generally referred to as cold transfer molding, the upper portion of the mould where the material-feeding channels or sprues are contained is to be maintained to a thermally controlled temperature through  
15 fluid circulation so that the material does not chemically react giving rise to a vulcanization reaction. The mould portion holding the impressions is, on the contrary, heated by means of electric resistances to the vulcanization temperature and gives rise to vulcanization of the material  
20 injected into the mould.

An insulating material constituting the breaking point between the two temperatures is interposed between the two mould portions, whereas the ducts along which the thermal fluid runs and the electric resistances perform the  
25 function of thermoregulating the mould to the due temperatures. With such a known structure it is rather difficult to have a well precise and localized temperature transition point and it is more likely that the temperatures should be distributed along the sprues,

exposing the material therein to an excessive temperature, which is so close to the vulcanization temperature that scorching phenomena during the injection may be caused so that a scrap increase occurs.

5 In addition, sprues must pass through the insulating material layer. Due both to the high abrasiveness of the injected material and the reduced resistance of the insulating materials to be employed, the mould duration is seriously impaired.

10 In the known art it was proposed to coat the channels at the passage through the insulating material by interposition of small cylinders of steel material. This solves the problem of wear but unfortunately in turn gives rise to heat migration exactly from the region where the  
15 maximum thermal control would be necessary.

As a further problem, due to the necessity to receive in the mould the thermal-fluid ducts and the housing accommodating the resistances (which resistances, taking into account the concerned power, must have important  
20 sizes), as well as to the necessity for a suitable thermal separation between the two regions, the feeding channels are compulsorily to be made rather long in the hot region causing, as a result, formation of sprues of relatively extended length. This leads to a material waste that, in  
25 particular in the case of particularly valuable materials, greatly affects the costs of the molded product, above all if it is of small sizes.

Also proposed have been moulds in which the mould is separable into a first portion containing the first

sections of the feeding channels and a second portion containing end sections of the feeding channels and the molding impressions. After rubber injection, a heated plate-like element is inserted between the first and second  
5 mould portions to bring the mould portion containing the impressions to a vulcanization temperature. The known plate-like element has a simple structure with a heating resistance close to the face in contact with the second mould portion. A layer of insulating material separates the  
10 resistance from the face of the plate-like element that is in contact with the first mould portion to prevent the plate from heating too much on such a side and cause vulcanization of the material in the feeding channels in the first portion too. The insulating material however has  
15 a reduced efficiency because the plate-like element must be preferably maintained to a small thickness.

In US 4,089,926 a proposal has been made of increasing efficiency of the thermal insulation by means of cooling channels placed between the resistance and the insulating  
20 layer. This hinders heat passage towards the first mould portion but does not supply any type of control on the temperature of said first mould portion.

In addition, since the end portion of the ducts close to the impressions is in any case exposed to the vulcanization  
25 temperature, the material therein is submitted to vulcanization and must be removed at the end of each molding cycle. In the case of molding with side channels, the vulcanized material in the channels keeps attached to the molded product and can be easily removed therewith. In

the case of molding of the "capillary" type on the contrary, the end portion of the ducts tapers into a cone-shaped configuration towards the impression and therefore it is not possible to slip the material off pulling it towards the impression. On the contrary, it must be separated from the molded product and the resulting plug or sprue must be extracted in the opposite direction, with a further operation distinct from the operation for extracting the molded product. The plugs or sprues to be extracted are all separated from each other and of a relatively great number. As can be easily understood, the extraction operation is therefore rather hard and the time required for a complete extraction is very long. In addition, if an automated extraction is wished to be obtained, very expensive and delicate unloading apparatus are to be manufactured, which practically will make the automatic unloading inconvenient.

In an attempt to solve the problem, moulds have been proposed in which there is an opening plane of the mould in an intermediate region of the end portion of the channels, in the neighborhood of the separation point between the vulcanized region and semi-vulcanized region of the material in the end ducts. Before each mould closure, a sheet of a so-called "fabric", i.e. a non-woven fabric of a particular texture, is inserted in this opening plane. The sheet enables clinging of the rubber filtering therethrough during the injection step, allowing extraction of all plugs with a single movement of removing the sheet after vulcanization and reopening of the mould.

Use of fabrics however has some contraindications. First of all the cost, which is sometimes so high that it even exceeds the cost for use of a hot transfer (involving a much higher material waste for each molding operation).

5 Secondly, the material of which the fabric is made is a thermoplastic material so that at high working temperatures it loses its consistency and can leave some plugs in place in the mould, which will bring about an important hindrance to production; or alternatively the fabric or pieces  
10 thereof can be carried along into the impression by the injected material flow, giving rise to scraps of the product.

DE 31 22 566 discloses use of a plate having projections each of which fits into a plug for extracting the latter  
15 from the channel on moving of the plate apart. But the projections cause side leakage of the rubber from the channels and, as a result, soiling of the mould, and difficulties in terms of closure and removal.

Due to the relatively high length of the sprues to be  
20 extracted, removal of same is made still more difficult, even by use of said fabric.

It is a general aim of the present invention to obviate the above mentioned drawbacks by providing a molding system enabling a great reduction in the scraps and the waste  
25 material to be obtained due to an important reduction in the length of the sprues and to a satisfactory thermal separation between the vulcanization region and the material-feeding region.

## SUMMARY OF THE INVENTION

In view of the above aim, in accordance with the invention, an injection molding system for a material vulcanizable by heat has been conceived which comprises a mould with molding impressions fed from channels for feeding the material in the fluid state and means for vulcanizing the material in the impressions, characterized in that the mould is separable into a first portion containing first sections of the feeding channels and a second portion containing end sections of the feeding channels and the molding impressions, the vulcanizing means comprising an element that is interposed in contact relationship between said first and second mould portions after feeding of the material to the impressions and in turn comprising first means for maintaining the element surface coming into contact with the first portion to a temperature suitable to avoid vulcanization of the material in the first channel sections, and second means for heating the opposite element surface coming into contact with the second mould portion to a temperature high enough to bring the material in the impressions to a temperature adapted to vulcanization of same, around the channels the first mould portion extending into the second portion so that the end sections of the channels remaining in the second portion have a reduced length.

## BRIEF DESCRIPTION OF THE DRAWINGS

For better explaining the innovative principles of the

present invention and the advantages it offers over the known art, a possible exemplary embodiment applying such principles will be described hereinafter, with the aid of the accompanying drawings: In the drawings:

- 5 - Fig. 1 is a diagrammatic exploded elevation side view in section of a molding system in accordance with the invention;
- Fig. 2 represents a diagrammatic view of a detail of the mould in Fig. 1 to an enlarged scale;
- Fig. 3 is a view of the system in a first operating step;
- 10 - Fig. 4 is a view of the system in a second operating step;
- Fig. 5 is a diagrammatic exploded elevation side view in section of an alternative embodiment of the molding system in accordance with the invention;
- Fig. 6 represents a diagrammatic view of a detail of the  
15 mould in Fig. 5 to an enlarged scale;
- Fig. 7 is a view of the system in Fig. 5 in a first operating step;
- Fig. 8 is a view of the system in Fig. 5 in a second operating step;
- 20 - Fig. 9 is a view of an element of the system in Fig. 5 in a third operating step;
- Fig. 10 is an enlarged view of a detail of the element in Fig. 9;
- Fig. 11 is a diagrammatic exploded elevation side view in  
25 section of a third embodiment of a molding system in accordance with the invention;
- Fig. 12 is a diagrammatic view of a detail of the mould in Fig. 11 to an enlarged scale.

## DETAILED DESCRIPTION OF THE INVENTION

With reference to the drawings, a first injection molding system (generally identified with 10) for a material  
5 vulcanizable by heat such as rubber, elastomers or the like is shown in Fig. 1.

The system, between two press plates 11 and 12, comprises a mould 13 with impressions or molding chambers 14 that are fed from appropriate channels for feeding the material in  
10 the fluid state. The injection system therein shown is of the type usually known as "cold transfer molding" in which the fluid material is injected from a source (not shown) into a transfer cylinder 15 and therefrom to impressions 14 during a transfer step caused by closure of the press. This  
15 transfer system is not hereinafter further described or shown, as it can be easily envisaged by a persons skilled in the art.

As clearly shown in Fig. 1, in accordance with a principle of the invention, the mould is made separable into a first  
20 portion 16 containing first sections 17 of the feeding channels and a second portion 18 containing end sections 19 of the feeding channels and the molding impressions 14. In the mould shown by way of example, injection into the impressions is of the side type.

25 Portion 18 containing the impressions obviously can be conveniently opened (line 20) for extraction of the molded articles.

For vulcanization of the material injected into the impressions, appropriate heating means is provided. Said



heating means comprises an element 21 that (as clarified in the following) is interposed in contact relationship between the first and second portions of the mould after feeding of the material to the impressions. In addition, 5 the mould portion provided with impressions 14 is supported by the respective press plate 12 through interposition of a known heating platform 22.

The intermediate element 21 in turn comprises first means 25, 27 designed to keep the element surface 23 coming into 10 contact with the first mould portion 16 to a temperature adapted to avoid vulcanization of the material in the first channel sections 17, and second means 26 designed to heat the opposite element surface 24 coming into contact with the second mould portion 18 to a temperature high enough to 15 bring the material in the impressions 14 to a temperature adapted to vulcanization of same.

The first means comprises a circuit for forced circulation of a fluid (advantageously a thermal carrier liquid) through ducts 25 disposed in a region 34 of element 21 20 which is close to the element contact surface 23 with the first mould portion 16.

As will be apparent in the following, the fluid fed into ducts 25 will be a thermoregulated fluid (by heat-exchanger means known in itself, and therefore not shown in detail) 25 to keep its temperature to a pre-established and appropriate temperature range. This will enable the face 23 of element 21 to be maintained within a pre-established temperature range (under the vulcanization temperature but close thereto). Therefore the first means is not used for

carrying out a mere and indiscriminate cooling but it is also an active thermoregulating means to control temperature of the surface 23 of element 21.

The second means comprises electric heating resistances 26  
5 disposed in a region 35 of element 21 that is close to the element contact surface 24 with the second mould portion 18. The two regions 34 and 35 are separated by a region 27 made of a suitable thermally insulating material to reduce heat transfer between the two regions 34 and 35 to a  
10 satisfactory value.

As clearly viewed still from Fig. 1, around the feeding channels the first mould portion 16 further extends by means of projections 28 to be fitted into mating seats 29 in the second mould portion 18 to bring the channel  
15 sections 17 in the first portion to match the end sections 19 in the second portion. In this way a reduced length of the end sections of the channels present in the second portion is obtained.

Surfaces 23, 24 of element 21 that are the contact surfaces  
20 with the respective surfaces 30, 31 of the first and second mould portions are shaped in a complementary manner with the latter so as to have seats 32 for receiving projections 28, as well as projections 33 intended for fitting into the underlying seats 29.

25 Advantageously, for reasons to be clarified in the following, in the material feeding direction the first sections 17 of the feeding channels taper, the end sections 19 become wider at least at the beginning, and in the transition or interface region between the first section

and end section of the channel a sudden widening 36 of the feeding channel occurs, as clearly shown in Fig. 2.

The molding system in use contemplates a first step in which the intermediate element 21 is removed and the press  
5 is operated to the appropriate pressure so that the mould portions 16 and 18 are moved close to each other and the normal injection step with material transfer to the impressions 14 through the feeding channels occurs, as shown in Fig. 3.

10 After filling of impressions 14, the mould portions 16, 18 are moved again away from each other. During this step, region 36 at the joining point between the two sections 17 and 19 of the feeding channels constitutes the frangible point of the material in the channel itself.

15 Subsequent to the above separation, element 21 is inserted between the two mould portions and the press is operated again and closed to the established pressure for the vulcanization step (Fig. 4). Movement of element 21 may take place through automated actuating means not shown  
20 because it can be easily envisaged by a person skilled in the art.

Thus the mould portion provided with the impressions is brought to the vulcanization temperature (which temperature depends on the molded material and is typically in the  
25 neighborhood of 200°C). On the contrary, the vulcanization heat is prevented from reaching the feeding channels in portion 16 due to the insulating material 27 and to the liquid running in ducts 25. The liquid will be maintained to a suitable temperature so as to achieve a

thermoregulation avoiding the material temperature in the channel sections 17 coming inconveniently close to the vulcanization temperature (for instance, the temperature can be maintained in the neighborhood of 60-100°C), but  
5 also advantageously preventing the temperature from becoming too much low as compared with the vulcanization temperature.

When the vulcanization step has been completed, the mould can be opened, the molded pieces removed and the cycle can  
10 be started again with a new injection step.

Shown in Fig. 5 is a second embodiment applying the principles of the invention. For the sake of clarity, elements similar to those of the previous embodiment will be denoted by the same reference numerals increased by 100.  
15 Thus, there is a system 110 that, between two press plates 111 and 112, comprises a mould 113 with impressions or molding chambers 114 that are fed from appropriate channels for feeding the material in the fluid state. The fluid material is injected from a source (not shown) into a  
20 transfer cylinder 115 and therefrom to impressions 114 during a transfer step caused by closure of the press.

As clearly shown in Fig. 5, the mould is made separable into a first portion 116 containing first sections 117 of the feeding channels and a second portion 118 (susceptible  
25 of opening for extraction of the molded products) containing end sections 119 of the feeding channels and the molding impressions 114. The end sections 119 taper towards the impressions 114. The upper plate of portion 118 holding the end sections 119 will have a low thickness sufficient

to resist the efforts to which it is submitted.

Advantageously, the channel sections 117 and 119 will have a junction interface made in known manner (with a sudden section change, for example) so as to promote separation of the material on separation of portions 116, 118. Sections 117 can also be made of conical shape opposite to the conical shape of sections 119.

For vulcanization of the material injected into the impressions, appropriate heating means is provided.

10 An intermediate element 121 is interposed in contact relationship between the first and second mould portions after material feeding to the impressions, and creates insulation between the first and second mould portions.

As can be seen in Fig. 5 and, to an enlarged scale in Fig. 6, the surface 124 of element 121 comprises fitting projections 140 that are conveniently positioned and sized for entering the channel sections 119 when the surface 124 of element 121 is brought into contact with the corresponding surface 131 of the mould portion 118.

20 Projections 140 are shaped for clinging to the material being vulcanized in the duct section 119. The projection shape is such selected that the clinging force is sufficient to cause extraction of the plug from the duct, but low enough to enable the subsequent separation of the material plug from the projection. As shown in Fig. 6, projections 140 are for example shaped with a sufficient undercut 141 and advantageously have a tapered head end for easy penetration into the material before vulcanization.

As clearly viewed from Fig. 6, around each projection 141,

the surface 124 has a relief 142 of a volume adapted to receive the material coming out of duct 119 when projection 140 penetrates thereinto. In other words, the chamber formed of the relief 142 is of at least the same volume as  
5 the projection portion 140 entering the duct 119.

As in the preceding embodiment, the intermediate element 121 in turn comprises first means 125, 127 designed to keep the element surface 123 coming into contact with the first mould portion 116 to a temperature adapted to avoid  
10 vulcanization of the material in the first channel sections 117, and second means 126 designed to heat the opposite element surface 124 coming into contact with the second mould portion 118 to a temperature high enough to bring the material in the impressions 114 to a temperature adapted to  
15 vulcanization of same. The first means comprises a circuit for forced circulation of a thermoregulated fluid through ducts 125 disposed in a region 134 of element 121 which is close to the element contact surface 123 with the first mould portion 116. The second means comprises electric  
20 heating resistances 126 disposed in a region 135 of element 121 that is close to the element contact surface 124 with the second mould portion 118. The two regions 134 and 135 are separated by a region 127 made of a suitable thermally insulating material to reduce heat transfer between the two  
25 regions 134 and 135 to a satisfactory value.

Advantageously, the mould portion provided with impressions 114 is supported by the respective press plate 112 through interposition of a known heating platform 122.

During use of the molding system, the operating steps are

similar to those described for the preceding embodiment. There is a first step in which the intermediate element 121 is removed. After filling of the impressions 114, the mould portions 116, 118 are moved apart again and element 121 is  
5 inserted for the vulcanization step.

When the vulcanization step is over, the mould is opened, and the molded pieces can be removed. Simultaneously, element 135, by moving away from the mould surface 131, extracts all plugs 143 from the channel sections 119.

10 Plugs 143 can then be easily removed from the projections by means of known means contemplating a rotating brush 144, for example, as shown in Fig. 10. For obtaining easy removal, the height of the projection 140 can be advantageously greatly smaller than the length of the  
15 extracted plug, so that removal takes place by side bending of the plug on the projection.

Thus, the molding cycle can start again with a new injection step.

Shown in Fig. 11 is an alternative embodiment of the mould  
20 in accordance with the invention. For the sake of clarity elements similar to those of the prior embodiments will be denoted by the same reference numerals increased by 200.

System 210, between two press plates 211 and 212, comprises a mould 213 with impressions or molding chambers 214. The  
25 fluid material is injected from a source (not shown) into a transfer cylinder 215 and therefrom to impressions 214.

The mould is made separable into a first portion 216 containing first sections 217 of the feeding channels and a second portion 218 containing end sections 219 of the

feeding channels and the molding impressions 214. In the mould shown by way of example injection into the impressions is of the lateral type.

The portion 218 containing the impressions can be obviously  
5 suitably opened (line 220) for extraction of the molded products.

For vulcanization of the material injected into the impressions, appropriate heating means is provided. Said means comprises an element 221 that is interposed in  
10 contact relationship between the first and second mould portions after material feeding to the impressions. In addition, the mould portion provided with the impressions 214 is supported by the respective press plate 212 through interposition of a known heating platform 222.

15 The intermediate element 221 in turn comprises first means 225, 227 designed to keep the element surface 223 coming into contact with the first mould portion 216 to a temperature adapted to avoid vulcanization of the material in the first channel sections 217, and second means 226  
20 designed to heat the opposite element surface 224 coming into contact with the second mould portion 218 to a temperature high enough to bring the material in the impressions 214 to a temperature adapted to vulcanization of same.

25 The first means comprises a circuit for forced fluid circulation through ducts 225 disposed in a region 234 of element 221 which is close to the element contact surface 223 with the first mould portion 216.

The second means comprises electric heating resistances 226



disposed in a region 235 of element 221 that is close to the element contact surface 224 with the second mould portion 218. The two regions 234 and 235 are separated by a region 227 made of a suitable thermally-insulating material  
5 to reduce heat transfer between the two regions 234 and 235 to a satisfactory value.

Around the feeding channels, the first mould portion 216 extends by means of projections 228 to be fitted into mating seats 229 in the second mould portion 218 to bring  
10 the channel sections 217 in the first portion to match with the end sections 219 in the second portion. In this way a reduced length of the end sections of the channels present in the second portion is obtained.

Surfaces 223, 224 of element 221 that are the contact  
15 surfaces with the respective surfaces 230, 231 of the first and second mould portions are shaped in a complementary manner with the latter so as to have seats 232 for receiving projections 228, as well as projections 233 intended for fitting into the underlying seats 229.

20 Shown in detail in Fig. 12 is a preferred embodiment of projections 228, made in the form of screwed injectors or injectors axially slidable over a small stretch against an elastic force in the body of portion 216.

As can be clearly seen in this figure, advantageously, the  
25 first section 217 of the feeding channel tapers in the material feeding direction. The end section 219 becomes wider at least at the beginning, and in the transition or interface region between the first section and end section of the channel a sudden widening 236 of the feeding channel

occurs. The junction line or plane between the first and second channel sections is substantially coincident with the opening line or plane 220 of the molding cavities in the second portion. In other words, the nozzle 228 has its end reaching the opening plane of the mould.

Advantageously, the injector has its point end 241 of conical shape to be received almost snugly and substantially sealingly into a matching conical seat 240 constituting the bottom of seat 229 in the second mould portion.

The mould shown in Fig. 12 has molding cavities 214 to make gaskets of the O-ring type.

Each injector terminates in the middle of the O-ring to feed rubber in a radial manner thereto.

With injectors in accordance with the invention and directly injecting on the mould plane from the side of the moving plane, automatic extraction of the molded articles has been found particularly easy. Not only extraction of the pieces is made easier, but a further rubber saving is also obtained as well as the certainty that no rubber remains in the mould on the side of the moving plane thereby creating possible waste material.

In use, in a first step the intermediate element 221 is removed and the material is injected into the impressions 214 through the injectors. Element 221 is then inserted between the two mould portions through means known in itself (not shown) and the press is closed again to the established pressure for the vulcanization step. The mould portion provided with the impressions is brought to the

vulcanization temperature while the liquid in ducts 225 keeps the mould portion provided with channels 217 to a suitably lower temperature (60-100°C, for example) thereby avoiding vulcanization of the material therein. When the  
5 vulcanization step has been completed in the impressions, the mould is opened, the molded pieces removed and the cycle can start a new injection step again.

At this point it is apparent that the intended purposes have been achieved, by making an intermediate element  
10 divided into a first portion or layer which is thermoregulated to maintain it to a temperature close to but lower than the vulcanization temperature (it may be even little lower but always in a fully safe manner) and a second portion or layer that is heated to the vulcanization  
15 temperature, with the two portions advantageously separated by a thermally insulating layer for more thermal independence.

It is apparent that the length of the vulcanized sprue (corresponding to the end section 19, 119, 219 alone) is  
20 reduced and represents a small percentage of the length obtainable with known systems. In addition, the risk of vulcanizations or pre-vulcanizations of the material remaining in the channels for the subsequent molding cycle is completely avoided.

25 With the system in accordance with the invention, the amount of waste material and scraps is greatly reduced as compared with known systems, without unacceptable slowing down or complexity in the molding cycle taking place for this reason.

Extraction of the vulcanized sprues or plugs is efficient, simple and reliable.

Obviously, the above description of an embodiment applying the innovative principles of the present invention is given  
5 by way of example only and therefore must not be considered as a limitation of the scope of the patent rights herein claimed. For example, sizes and proportions of the different parts and number and arrangement of the impressions and feeding channels can vary depending on  
10 specific requirements. Projections 40 can consist of inserts that are locked, by means of screws for example, into appropriate seats in the body of the intermediate element, either directly or by interposition of a suitable plate.